Claims

1. An integrated circuit having a voltage variable capacitor, the circuit including:
a first semiconductor layer;
a second semiconductor layer formed on the first semiconductor layer including a material having a higher resistivity than the first semiconductor layer;
a conductive electrode; and
an insulating layer formed between the second semiconductor layer and the electrode, the insulating layer including a substantially monocrystalline layer.

2. An integrated circuit according to claim 1, wherein the monocrystalline layer includes at least one of a metal oxide, metal nitride, alkaline earth metal titanate, alkaline earth metal zirconate, alkaline earth metal hafnate, alkaline earth metal tantalate, alkaline earth metal niobate, alkaline earth metal vanadate, alkaline earth metal tin-based perovskite, lanthanum aluminate, lanthanum scandium oxide, gadolinium oxide, alkaline earth oxides, gallium nitride, aluminum nitride, boron nitride, strontium titanate, $BaTiO_3$, $LaAlO_3$, $SrZrO_3$, $BaZrO_3$, and MgO.

3. An integrated circuit according to claim 1, wherein the monocrystalline layer is substantially lattice matched to at least one of the first semiconductor layer and the second semiconductor layer.

4. An integrated circuit according to claim 3, wherein a structure of the monocrystalline layer is rotated approximately 45 degrees with respect to a structure of the at least one of the first semiconductor layer and the second semiconductor layer.

5. An integrated circuit according to claim 1, further including an interface layer disposed between the insulating layer and the second semiconductor layer.

6. An integrated circuit according to claim 5, wherein the interface layer includes at least one of a metal oxide, metal nitride, gallium nitride, aluminum nitride, boron nitride, strontium silicate, and strontium oxide.

7. An integrated circuit according to claim 1, wherein the insulating layer is formed epitaxially.

8. A method of making a voltage variable capacitor, including:
providing high resistivity material on a semiconductor;
providing a substantially monocrystalline insulating material on the high resistivity material; and
providing an electrode on the insulating material.

9. A method according to claim 8, wherein providing the insulating material includes at least one of a molecular beam epitaxy, vapor phase epitaxy, pulsed laser deposition, sputtering, evaporation, chemical vapor deposition, ion beam, plasma, sol-gel, and solution chemistry process.

10. A method according to claim 8, wherein the insulating material includes at least one of a metal oxide, metal nitride, alkaline earth metal titanate, alkaline earth metal zirconate, alkaline earth metal hafnate, alkaline earth metal tantalate, alkaline earth metal niobate, alkaline earth metal vanadate, alkaline earth metal tin-based perovskite, lanthanum aluminate, lanthanum scandium oxide, gadolinium oxide, alkaline earth oxides, gallium nitride, aluminum nitride, boron nitride, strontium titanate, $BaTiO_3$, $LaAlO_3$, $SrZrO_3$, $BaZrO_3$, and MgO.

11. A method according to claim 8, wherein providing the insulating material includes substantially lattice matching a structure of the insulating material to a structure of at least one of the high resistivity material and the semiconductor.

12. A method according to claim 11, wherein providing the insulating material includes rotating the structure of the insulating material approximately 45 degrees with respect to the structure of the at least one of high resistivity material and the semiconductor.

13. A method according to claim 8, further including providing an interface layer between the insulating material and the high resistivity material.

14. A method according to claim 13, wherein providing the high resistivity material on the semiconductor occurs prior to the step of providing the interface layer.

15. A method according to claim 13, wherein the interface layer includes at least one of a metal oxide, metal nitride, gallium nitride, aluminum nitride, boron nitride, strontium silicate, and strontium oxide.

16. A semiconductor device, including:
a semiconductor material;
a conductive element; and
a substantially monocrystalline insulator disposed between the semiconductor material and the conductive element.

17. A semiconductor device according to claim 16, wherein the semiconductor material includes a silicon substrate.

18. A semiconductor device according to claim 16, further including a high-resistivity layer disposed between the insulator and the semiconductor material.

19. A semiconductor device according to claim 18, wherein the high-resistivity layer is an epitaxial layer.

20. A semiconductor device according to claim 16, wherein the insulator includes at least one of a metal oxide, metal nitride, alkaline earth metal titanate, alkaline earth metal zirconate, alkaline earth metal hafnate, alkaline earth metal tantalate, alkaline earth metal niobate, alkaline earth metal vanadate, alkaline earth metal tin-based perovskite, lanthanum aluminate, lanthanum scandium oxide, gadolinium oxide, alkaline earth oxides, gallium nitride, aluminum nitride, boron nitride, strontium titanate, $BaTiO_3$, $LaAlO_3$, $SrZrO_3$, $BaZrO_3$, and MgO.

21. A semiconductor device according to claim 16, wherein the insulator includes strontium titanate.

22. A semiconductor device according to claim 16, wherein the insulator is substantially lattice matched to the semiconductor material.

23. A semiconductor device according to claim 22, wherein the structure of the insulator is rotated approximately 45 degrees with respect to the structure of the semiconductor material.

24. A semiconductor device according to claim 16, further including an interface layer disposed between the insulator and the semiconductor material.

25. A semiconductor device according to claim 24, wherein the interface layer includes at least one of a metal oxide, metal nitride, gallium nitride, aluminum nitride, boron nitride, strontium silicate, and strontium oxide.

26. A semiconductor device according to claim 16, wherein the semiconductor device includes a capacitor.

27. A semiconductor device according to claim 16, wherein the semiconductor device includes a voltage variable capacitor.

28. A semiconductor device according to claim 16, wherein the insulator is formed epitaxially.

29. A radio circuit having a frequency dependent circuit, the frequency dependent circuit including at least one voltage variable capacitor, and the voltage variable capacitor including:
a semiconductor substrate;
a high resistivity semiconductor layer on the semiconductor substrate;
a substantially monocrystalline dielectric layer formed on the high resistivity layer; and
an electrode formed on the dielectric layer.

30. A radio circuit according to claim 29, wherein the dielectric layer includes includes at least one of a metal oxide, metal nitride, alkaline earth metal titanate, alkaline earth metal zirconate, alkaline earth metal hafnate, alkaline earth metal tantalate, alkaline earth metal niobate, alkaline earth metal vanadate, alkaline earth metal tin-based perovskite, lanthanum aluminate, lanthanum scandium oxide, gadolinium oxide, alkaline earth oxides, gallium nitride, aluminum nitride, boron nitride, strontium titanate, $BaTiO_3$, $LaAlO_3$, $SrZrO_3$, $BaZrO_3$, and MgO.

31. A radio circuit according to claim 29, wherein the dielectric layer is substantially lattice matched to the high resistivity semiconductor layer.

32. A radio circuit according to claim 31, wherein the structure of the dielectric layer is rotated approximately 45 degrees with respect to the structure of the high resistivity semiconductor layer.

33. A radio circuit according to claim 29, wherein the dielectric layer includes strontium titanate.

34. A radio circuit according to claim 29, further including an interface layer disposed between the insulator and the semiconductor material.

35. A radio circuit according to claim 34, wherein the interface layer includes at least one of a metal oxide, metal nitride, gallium nitride, aluminum nitride, boron nitride, strontium silicate, and strontium oxide.

36. A semiconductor device, comprising:
a semiconductor substrate and a conductive element; and
an insulating layer disposed between the semiconductor substrate and the conductive element, wherein the insulating layer includes a substantially monocrystalline material.

37. A semiconductor device according to claim 36, wherein the semiconductor device is a capacitor.

38. A semiconductor device according to claim 36, further including a layer of semiconductor material having a higher resistivity than the semiconductor substrate disposed between the semiconductor substrate and the insulating layer.

39. A semiconductor device according to claim 38, wherein the higher resistivity layer is an epitaxial layer.

40. The semiconductor device as described in claim 38 wherein the semiconductor device is a voltage variable capacitor.

41. A semiconductor device according to claim 36, wherein the monocrystalline material comprises at least one of a metal oxide, metal nitride, alkaline earth metal titanate, alkaline earth metal zirconate, alkaline earth metal hafnate, alkaline earth metal tantalate, alkaline earth metal niobate, alkaline earth metal vanadate, alkaline earth metal tin-based perovskite, lanthanum aluminate, lanthanum scandium oxide, gadolinium oxide, alkaline earth oxides, gallium nitride, aluminum nitride, boron nitride, strontium titanate, $BaTiO_3$, $LaAlO_3$, $SrZrO_3$, $BaZrO_3$, and MgO.

42. A semiconductor device according to claim 36, wherein the monocrystalline material is substantially lattice matched to the semiconductor substrate.

43. A semiconductor device according to claim 42, wherein a structure of the monocrystalline material is rotated approximately 45 degrees with respect to the semiconductor substrate.

44. A semiconductor device according to claim 36, further including an interface layer disposed between the insulating layer and the semiconductor substrate.

45. A semiconductor device according to claim 44, wherein the interface layer is comprised of at least one of a metal oxide, metal nitride, gallium nitride, aluminum nitride, boron nitride, strontium silicate, and strontium oxide.

46. A semiconductor device according to claim 36, wherein the insulating layer is formed epitaxially.

47. A voltage variable thin film capacitor, comprising;

a first semiconductor layer;

a second semiconductor layer of a higher resistivity semiconductive material formed on the first semiconductor layer;

an insulating layer formed on the second semiconductor layer comprising a thin film of substantially monocrystalline material; and

a conductive electrode formed on the insulating layer.

48. A voltage variable thin film capacitor according to claim 47, wherein the monocrystalline material comprises at least one of a metal oxide, metal nitride, alkaline earth metal titanate, alkaline earth metal zirconate, alkaline earth metal hafnate, alkaline earth metal tantalate, alkaline earth metal niobate, alkaline earth metal vanadate, alkaline earth metal tin-based perovskite, lanthanum aluminate, lanthanum scandium oxide, gadolinium oxide, alkaline earth oxides, gallium nitride, aluminum nitride, boron nitride, strontium titanate, $BaTiO_3$, $LaAlO_3$, $SrZrO_3$, $BaZrO_3$, and MgO.

49. A voltage variable thin film capacitor according to claim 47, wherein the structure of the monocrystalline material is substantially lattice matched to at least one of the first or second semiconductor layer.

50. A voltage variable thin film capacitor according to claim 49, wherein the structure of the monocrystalline material is rotated approximately 45 degrees with respect to the structure of the at least one of the first or second semiconductor layer.

51. A voltage variable thin film capacitor according to claim 47, further including an interface layer disposed between the insulating layer and the second semiconductor layer.

52. A voltage variable thin film capacitor according to claim 51, wherein the interface layer is comprised of at least one of a metal oxide, metal nitride, gallium nitride, aluminum nitride, boron nitride, strontium silicate, and strontium oxide.

53. A voltage variable thin film capacitor according to claim 47, wherein the insulating layer is formed epitaxially.